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Patterns of Strain as Indicators of Demand Management: The Diagnostic Role of Fatigue

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Summary

The paper presents an analysis of strain in complex work, based on a separation of two components of the strain state: anxiety and fatigue. The analysis uses a model of demand management that derives from a self-regulation framework of goal-oriented action. In this, demands are regulated either by low-level routine processes, or by intervention of a higher level supervisory mechanism, which allocates effort resources according to overall priorities for well-being or task goals. In the model, anxiety and fatigue are treated as metacognitive processes, reflecting the adaptive response to environmental change. Anxiety is associated with the output of an 'action monitor', and interpreted as equivalent to the perception of an imbalance in current and environmental demand (threat), while fatigue is associated with the extended use of the high-effort control mode in meeting these demands. The model makes a number of predictions about patterns of dissociation between the two strain indicators, and their relation to performance and physiological effects of coping. These are illustrated with reference to several studies of the work of junior hospital doctors. An argument is made for the more widespread use of multiple observations within individuals, in order to provide more direct evidence on the functional mechanisms underlying the development of strain and health problems. Patterns of Strain as Indicators of Demand Management: The Diagnostic Role of Fatigue

1. Changing Patterns of Demand in Modern Work

The main aim of the paper is to examine the processes underlying patterns of strain in complex work. It puts forward a model of the effects of job demands and control on work strain, well-being and effectiveness, within an integrated cognitive-energetical framework. While the general form of the model applies to all kinds of complex work, the arguments are illustrated in the paper through a summary of a series of studies on the work of junior doctors in the UK National Health Service. Modern hospitals make very high levels of demand on junior medical staff. In addition to the rapid growth and change in medical knowledge, techniques and procedures, there are ever- increasing needs for accountability and efficiency, and constraints on decision-making from previously supportive financial and organisational factors (Payne and Firth- Cozens, 1987). These problems have to be seen in the context of the very long working weeks (currently averaging around 80 hours) of young hospital doctors, particularly in the UK, which has been shown to be pose serious threats to sleep and effectiveness of work. The overall effects of these demands on the health and job-satisfaction of junior doctors are dramatic (Spurgeon and Harrington, 1987), one study (Firth-Cozens; 1989) reporting a level of around 50% incidence of emotional disorder.

Demands and Control. Work demands have traditionally been assumed to play a major role in the aetiology of work stress and ill-health. More recently it has become clear that the controllability of the work environment is also important, and may even play a more important role than demands themselves (Karasek and Theorell, 1990). There has, however, been little agreement over the nature of either demands or control, or much systematic analysis of the mechanisms by which they may have their effects. For example, high levels of responsibility have sometimes been interpreted as an enabling (control) variable (Herzberg, 1966), sometimes an additional demand (Katz and Kahn, 1978; Cooper and Smith, 1985). Similar inconsistencies relate to the interpretation of repetitiveness of work cycles, machine pacing and time pressure (Hockey, 1993). Part of this uncertainty may lie in the lack of strong theory underlying the analysis of work

environments. A further complication, however, is that particular work features may contribute to either demand or control factors, depending upon individual appraisal of workplace events in relation to task and personal goals. To enable us to better understand their role in health and well-being, the constructs of demands and control need to be embedded within goal-directed broader theories of adaptive behaviour such as those of action theory (Frese and Sabini, 1985) or control theory (Carver and Scheier, 1982). In this kind of framework demands are identified as features of the environment which threaten the execution of goals, while control is defined in terms of the degree of flexibility available for achieving goals. It follows from any goal-level analysis that constructs need to interpreted at the individual level to have any validity.

A useful distinction may be made between cognitive, emotional and physical activities (Hockey, Briner, Tattersall and Wiethoff, 1989), based on the impact of environmental events on the three primary behavioural adaptation systems. One implication of this is that different kinds of adaptive response are appropriate for dealing with threats to emotional and cognitive goals, though we must also be aware that each may impinge on the other (Carver and Scheier, 1990). Increasingly, modern work is characterised by demands on mental processes, with physical demands reduced to a few movements of hands or fingers. The term 'mental' implies both emotional and cognitive processes. Emotional work may be defined as that which engages the emotional responses of the individual - typically in the form of social stressors such as conflicts and competitiveness, or threats to the welfare of self or significant others. In organisations such as hospitals and the caring professions emotional demands are inevitable, and recognised as important elements of the job (Payne and Firth-Cozens, 1987). On the other hand, such demands may represent an unplanned and highly stressful feature in many other areas of work, where social stress and interpersonal conflicts may be high, for example because of problems in organisational management or work design. The most obvious change in work demands over the past 25 years has been the dramatic increase in cognitive demands, which now represent the main source of work tasks for the majority of jobs. Cognitive work is characterised by the engagement of mental processes underlying the problem-solving response to the environment. It includes both

routine activities such as monitoring and pattern recognition, and higher-level activities such as thinking, reasoning and decision-making.

Complex Work. For the purposes of this paper, complex work is defined in terms of the a combination of high demand, low control and high cost responsibility. Such jobs involve highly-trained people within a 'professional' context; they make very high demands on both high level and routine cognitive resources (as well as emotional resources in some cases); they may have surprisingly high levels of constraints for the execution of what are typically highly-skilled, knowledge-based work tasks; and they have a high 'cost-responsibility' (where the consequences of error are very serious). Examples of such jobs are air traffic control, process control, and medical work. This last- mentioned context is a particularly good example, since it involves high levels of both cognitive and emotional load, and threat of loss of human life as the consequences of failure. In addition, there is a high level of public expectation about the capabilities and infallibility of doctors and nurses, which is impossible to live up to. Work of this kind may not be particularly vulnerable to error under stress and high workload. (Employees are typically well-motivated and skilled, as well as being supported by considerable technology). Such occupations are, however, vulnerable to ill-health consequences of their work. This is because of their in-built need to maintain performance standards, even when strain is high. A relaxation of their level of involvement may compromise safety criteria, and contribute to an accident or loss of life.

2. Task Performance and Strain at Work

This pattern of maintenance of performance across changing levels of resources and states of well-being has been referred to as 'performance protection' (see Hockey, 1993 for a review). The combination of performance and affect, including on-task effort, with the additional use of psychophysiological measures where appropriate, provides

a useful methodology for investigating strain patterns at the level of task goal management.

Patterns of Indirect Degradation. While performance protection is a normal feature of all cognitive behaviour (Kahneman, 1973), a state of strain may be assumed to result from sustained regulation of this type, particularly when adaptive capacity is reduced by other factors such as sleep loss or stress. In experimental studies of stressors and workload, the operation of performance protection makes it unusual to observe marked performance degradation even under extreme conditions. This applies especially to the work environment (Hockey, 1993), where external controls on productivity, safety, etc, help maintain task motivation at a high level.

Although degradation of primary task activity is unusual, several different forms of indirect degradation in adaptive capacity may be identified. (1) Compensatory costs may be seen in the form of sympathetic activation or the development of negative affect; (2) Strategy adjustments may be introduced, modifying the mode of task control to reduce its dependency on demanding cognitive processes such as working memory; (3) Fatigue after-effects may also be seen, usually taking the form of a preference for low-effort strategies on 'probe' tests following extended periods of high level work. The importance of this kind of analysis is that performance assessment has a major role to play in the interpretation of research on the impact of work environments. For example, a study on the impact of a changed work design may conclude that the intervention is benevolent because performance does not suffer (or even improves). Often, it is necessary to measures these secondary (covert) features of performance to test the validity of this conclusion. The use of such a methodology is very rare, though one recent exception illustrates its value clearly. Rissler and Jacobson (1987) found compensatory increases in adrenaline and effort in operators who maintained performance levels following the implementation of a new computer system.

Two Dimensions of Work Strain. The analysis of subjective strain and well-being typically involves the assessment of self-reports of affect, and often treats different

kinds of reports as equivalent. Thus, reduced job satisfaction, increased anxiety, depression or stress, or reports of physical symptoms may all be taken as indicators of a general reduction in well-being. It is now generally accepted that two (independent) affective state variables need to be distinguished, rather than an overall good-bad evaluation (Carver and Scheier, 1990; Watson and Tellegen, 1985). Mood states may be characterised by their location within the space defined by the two dimensions of hedonic tone (pleasure) and degree of activation (arousal). In our own work we have adopted the varimax rotated structure preferred by Watson and Tellegen (1985), and their terminology for these dimensions: positive and negative affect (PA and NA), broadly equivalent to factors of vital energy and tension/anxiety. This rotated two-factor solution is preferred to the unrotated pleasure-arousal solution of mood states, because of its demonstrated discriminant validity. It is, furthermore, consistent with current conceptions of emotional patterning (Frijda, 1986), and temperament (Eysenck and Eysenck, 1975), as well as providing a natural conceptual link with clinical depression and anxiety. Broadbent (1985) has shown that different kinds of work environment are associated with these two patterns of mental ill-health, anxiety with high rates of machine pacing, and depression with low job satisfaction and repetitiveness.

The PA-NA distinction is used as the basis of our two- dimensional analysis of strain states in terms of anxiety (high NA) and fatigue (low PA). The polarity of the PA dimension is reversed to identify fatigue as one of two positive components of the strain state. Both dimensions of strain differ somewhat from standard measures of NA and PA, in emphasising the short-term affective response to dynamic work environments. For anxiety these terms include anxious and worried, rather than broader aversive terms such as afraid or disgusted; for fatigue, fatigued and tired, rather than depressed or miserable). Within the context of the model of demand management outlined below, these two strain indicators are assumed to have a fairly specific diagnostic role. Anxiety is interpreted as an indicator of the overall level of perceived demand (extent to which work goals are appraised as being threatened by environmental events). The meaning of increases in reported fatigue is more complex, and still to be examined fully. Most directly, it is assumed to indicate the overall level of regulatory effort (extent to which

demands have been met by increased adaptive resources). Fatigue may also, however, reflect a tonic shift in perceived adaptive capacity, or a recognition of the personal costs associated with such a response. Fatigue is an important marker in the diagnosis of many health problems. We would argue that its dependence on the use of particular demand management strategies makes its role in the development of work-related stress and ill-health particularly significant.

3. Regulatory Processes in Demand Management

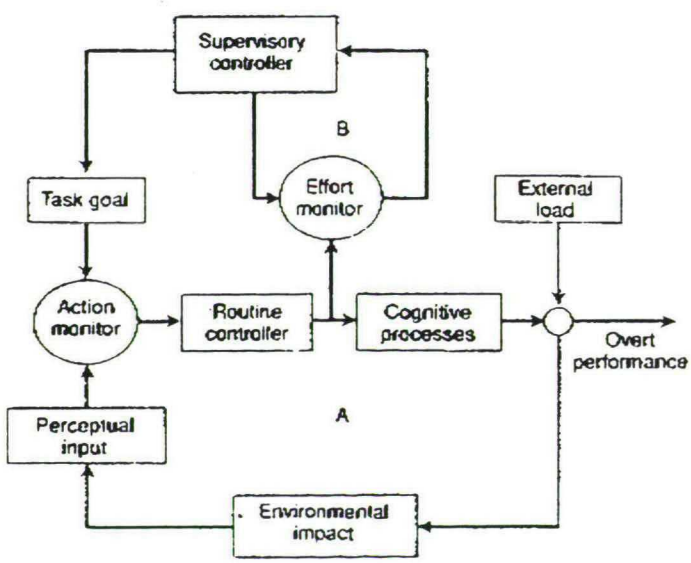
Self-regulation is assumed to be normal mode of control for human-environmental interaction (as for all mammals, at least). Behaviour is modified by reference to internal standards or set points, through negative feedback, in order that currently active goals may be maintained, and purposive behaviour promoted (Carver and Scheier, 1990; Powers, 1973). There is, however, an asymmetry in the control of emotional and cognitive behaviour. Emotion-based goals are self- energised, and sustained by powerful events, both in the environment itself (reactions of other people) and internal body mechanisms (physiological patterning). In contrast, cognitive goals appears to be vulnerable, and are protected by special purpose mechanisms such as attention (Kahneman, 1973). High levels of control are effective because they provide maximum flexibility of shifts in goal orientation (eg, because of tiredness or boredom). This feature is increasingly absent from modern work, which generally fails to support the requirements of self-regulation. It is thwarted by the essential requirement of paid employment, which is to maintain a strong orientation towards externally defined work goals over long periods. Such constraints may nevertheless be overcome by a work environmental design in which goals are defined in very broad terms, with a range of appropriate routes to the goals and flexible timing.

The State Regulation Model. As should be clear from what has been said so far, fatigue is assumed to be a state which develops as a result of a partial breakdown in the normal

regulatory process. It comes about when the environmental context of work inhibits the normal shifting of attentional goals or mode of environmental response. These assumptions have been developed over the past 10 years into a model of demand management, based on the self-regulatory conceptualisation of human behavioural control (Hockey and Hamilton, 1983; Hockey, 1986; Hockey, Briner, Tattersall and Wiethoff, 1989; Hockey, 1993). As in all models of this kind (eg, Carver and Scheier, 1990; Powers, 1973) behavioral output is stabilised by comparison of action with goal- referenced 'target' states, through negative feedback. Behaviour is regulated until this discrepancy between target state and current activity is eliminated.

Figure 1 illustrates the broad features of the model, with two main feedback loops. The lower loop (A) represents the process of routine regulation for a well-learned skill. The stability of overt performance may be threatened by several sources of perturbation, from both internal and external events, though it is normally maintained through routine control actions. The process is triggered by input from an 'action monitor' (comparator), which compares set task goal values with perceptual input from the current activity. The various action routine corrections activated by the discrepancy signal (speed, timing, patterning, and so on) proceed to modify behaviour until the discrepancy is resolved.

Figure 1: A two-level model of control and stress regulation see text for explanation



These routine corrections are frequently required, even for what are called 'automatic' cognitive skills, though they are assumed to be low-cost, and managed at a low level within the overall system architecture. A second level of control is assumed to be needed (loop B), however, to deal with non-routine regulation (where the discrepancy is too great for the range of routine skills available. This is signalled in this model by a (metacognitive) effort mechanism, which is sensitive to increasing control activity in the lower loop (for example, a failure to resolve the discrepancy, or a slow rate of resolution). In this case, control may be temporarily shifted to a higher level mechanism (here called the supervisory controller), where several optional modes of regulation are available. Effort is assumed to have both an upper and a lower set point. A default low level of effort tolerance (the effort budget) is set by the supervisory controller for a given task environment (based on the anticipated effort needs of the task, experience, current instructions, and so on). This may be considered to correspond, for example, with the level of intrinsic sympathetic activation, though the physiological basis of the model is not discussed here. Increases in energy demands below this level are not felt as effortful, and action control appears automatic. The upper level, by contrast, sets a maximum for effort expenditure (exceptional requirements, associated with unpredictable changes in the demands-resources balance). This may be based on individual long-term characteristics of effort tolerance and activation, as well as short-term factors such as available resources and goal priorities. The upper level may be set higher for activities which were more important, for example, or lower when overall resources had been impaired by illness or continued stress.

Effort-Fatigue Relationships. This is where our model of the fatigue process may be spelled out more clearly. Two distinct roles of the effort mechanism are envisaged, associated with changes at the lower and upper set points. Low level increases in perceived effort signal the need for some degree of supervisory involvement. This may require an adjustment of the lower set point (the effort budget), to allow routine correction to proceed at a higher level of involvement of active (non-automatic) processes. This would be necessary, for example, in imperfectly-learned skills, or when goals are set slightly higher than usual (under challenge or new learning situations).

Behavioural stability remains high under these conditions, and effort well within tolerance limits, though the overall level of mental activity is increased. This may be seen to correspond with Frankenhaeuser's description of challenge situations, which are associated with 'effort without distress', high catecholamines and low cortisol (Frankenhaeuser, 1986). Such regulatory activity is part of normal adaptive behaviour, being a central feature of all high-level cognitive activities (eg, Baddeley and Hitch, 1974; Rasmussen, 1986), and not normally a problem in work environments.

A more serious problem emerges, however, at high levels of demand, where the required effort budget approaches or exceeds the upper set point limit. First, consider marked increases in the set point, though still below the maximum. Although there is evidence that maximum effort limits are relatively conservative, even for physical activity (Holding, 1983), operating at this level of energetic involvement is likely to impose some degree of strain on the system. While short periods of effortful activity are quite normal, the requirement to sustain high levels of unplanned (low control) effort over long periods is known to be aversive, and has obvious cost implications. Continued use of high-level central control is thought to be the primary source of fatigue from mental work (Hockey, et al, 1989). In addition to the short-term impact of subjective fatigue (weariness and detachment), and possible longer term PA (depression and reduced job enthusiasm), there are short- term increases in both catecholamines and cortisol (Frankenhaeuser's effort with distress), and possible increases in the chronic level of circulating stress hormones.

As may be seen from Figure 1, two control options are available for resolving the discrepancy between set effort level and required effort. These involve an intrinsic trade-off between task performance and energetical costs. First, effort resources may be increased to meet the new level of demand. Performance criteria are maintained at the expense of an increase in effort-related energetical costs, and the development of a phasic fatigue state. Such costs may not pose any serious problem for the adaptive process. The required state change may be brief, or involve only a moderate increase in the effort budget, well below the upper limit. However, the cumulative effects of

repeated and extended use of this direct coping mode may have severe consequences for well-being. Second, performance criteria may be reduced (through moderation of the task goal), so that additional effort costs are not incurred. This may be done by reducing required levels of accuracy or speed, for example, or by adopting strategies which make less demands on high-level control. In extreme cases the individual may disengage completely from the goal when effort demands are too great to be contemplated. While this would be unlikely in most work contexts it would be natural adaptive response to perceived strain in a more controllable context, such as leisure activity. In work, whichever of these task-goal changes is adopted, the level of achieved performance is reduced.

Where demands are excessive (such that they exceed the set upper limit for effort expenditure), a different kind of problem may be observed. While a direct coping response may again be possible (and indeed necessary in emergency situations) it is very likely to be maladaptive where it becomes the normal mode of work. In addition, as demands at this level are close to the limits of system resources, they would be expected to have more serious consequences for adaptive capacity, associated with tonic fatigue states and possible longer-term ill-health.

4. Some Illustrative Findings on Fatigue Patterns in Junior Hospital Doctors

The above points may be illustrated through a summary of a number of studies carried out with various colleagues over the past few years. While these have been concerned with a range of research issues they have in common a primary interest in the relationship between workload and strain in hospital staff, both junior doctors and nurses (Hockey, 1993; Hockey and Wiethoff, 1990; Wiethoff and Hockey, in press). The studies have made use of longitudinal or multiple sampling techniques, with relatively small groups of participants, who have provided estimates of work demands, affective state and other measures on a number of occasions. The strength of this

method is that it allows us to use aggregated data based on standardised within-subject values.

In these studies subjective workload has been measured by a customised version of the Subjective Workload Assessment Technique, SWAT (Reid, Shingledecker and Eggemeier, 1981). In addition to ratings of cognitive, emotional and physical workload, it includes measures of personal control and support. The 5-item scale provides two higher order factors of general workload and resources (support and control). Strain is assessed through a 8-item mood adjective scale, giving measures of anxiety and fatigue, as defined earlier.

Intra-individual Analysis of Strain Patterns. Using within-subject analyses, workload effects are very pronounced. Whereas across-subject (cross-sectional) correlations with well-being are typically of the order of 0.2 or 0.3, those based on aggregated within-subject variations are around 0.6-0.8. In one study (Hockey and Wiethoff, 1990), a detailed longitudinal analysis was carried out of the work of two house officers (pre-registration doctors in their first full-time post) in the same cardio-thoracic unit of a large teaching hospital. They were assessed on every working day for six weeks, three times a day, on a range of questionnaires, performance tests and biochemical measures. They gave subjective reports of day to day changes in the quality and quantity of work demands and their affective state. The two doctors differed somewhat in the reported pattern and extent of workload , though the range was about the same, and the cross-correlation very high (0.79). Since their actual workload was very similar, differences between them may be interpreted in terms of individual appraisal of external demands. The correlations of reported workload with well-being were, however, very revealing. For anxiety, both doctors showed high correlations (0.7-0.8) with an overall index of workload, with emotional demands contributing most to this relationship. For fatigue, the effects were, however, startlingly different. The workload-fatigue correlation was moderately high for TD (around 0.5), and very low (close to 0) for CB: while TD reports tiredness at the end of busy days CB does not. A further analysis, using lagged regression, revealed a marked day to day carry over of workload to fatigue for CB, but

not for TD. The lack of response on day 1 means that many of the problems remain unresolved and need to be dealt with on day 2.

The pattern exhibited by TD is one of active direct coping. Fatigue is a consequence of the application of additional effort on demanding days, though it dissipates quickly. For CB the pattern is characteristic of a more passive response, with no attempt to increase effort under high demand. This suggests that task goals should be moderated downwards, as predicted by the demand regulation model. Although we were unable to obtain any direct measurements of performance, there is no doubt that TD was considered by the consultant to be the more 'dedicated' of the two, and the more reliable. For TD there was also an opportunity to examine the impact of a week's holiday, which came after a long unbroken work period. While the effects of workload on anxiety were the same both before and after the break the effect on fatigue was markedly reduced. The correlation beforehand was around 0.7, and afterwards actually negative (-0.3). Although these are based on rather small samples they illustrate two important principles. First, fatigue may indicate reduced efficiency in dealing actively with demands, as a result of cumulative work strain effects. The effect is abolished by a break from work, which may have the effect of restoring adaptive capacity. Second, where capacity is not tonically suppressed, mental demands of complex work such as this may be energising, rather than tiring, engaging interest and alert involvement. (The workload-adrenaline correlation showed parallel changes before and after the break, from 0.2 to around 0.5). Acute fatigue may be partly due to reduced adaptive capacity at the neuroendocrine level. Dynamics of the demands-affect relationship need to be more carefully established if we are to use them to explain the aetiology of health at work. Detailed individual cases may provide valuable data on this problem.

Coping Style. In a second study (Hockey and Wiethoff, 1990; Wiethoff and Hockey, in press) a group of 32 young doctors were sampled on a number of occasions over a 4-month period. Since there were not enough observations for each person to carry out within-subject analyses, aggregated analyses were performed instead (following standardising of all measures within each individual). Again, the overall workload-

anxiety correlation was high (around 0.75), and the workload-fatigue correlation rather moderate (0.35). However, for this group, we also had data on a measure of coping style, based on stated typical responses to a range of medical stress scenarios. These allowed us to classify individuals along dimensions of active-passive (degree of direct coping) and problem- or emotion-focused. Within the occupational context examined these were highly correlated, with most young doctors high on both active and problem-focused (direct coping) and few high on passive and emotion-focused (indirect coping). This allowed us to identify groups of direct and indirect copers, with the omission of a few indeterminate profiles. Coping style had no affect the impact of workload on anxiety, but it interacted strongly with its effect on fatigue. For doctors who could be classified as direct copers there was a marked increase in reported fatigue on high workload days, while for indirect copers there was no effect. As with the n=2 study, changes in the anxiety component of strain appear to reflect changes in perceived demand, and is a strong effect across both groups. The fatigue component instead follows the adoption of an active response to demand, in the form of direct coping attempts. There was another interesting difference between the two groups. Although active copers showed a greater responsiveness of fatigue to workload changes, their tonic level of reported strain was lower - they were both less anxious and less tired. The direct response to work demands in young doctors may thus be a functional and adaptive strategy, helping to maintain well-being. The reverse pattern of causality is also possible, of course: Active coping may only be an option for demand management when individuals are emotionally stable to begin with. The former explanation is probably correct since there were no differences in trait negative affectivity (neuroticism).

After-effects of Task Performance. In addition to the effects on subjective fatigue, the above study also measured objective effects on a medical decision-making performance task. This was devised specially to be sensitive to changes in strategy resulting from fatigue after-effects of demanding work days. As I have described earlier, such after-effects may indicate a reduced level of task effort. The task showed a detrimental effect of workload on both time and errors, as well as an increase in heart rate variability

(HRV), shown to be associated with reduced mental effort (Wiethoff and Hockey, in press). We also had data on the impact of long weekend shifts, which young doctors were required to work every few weeks. They are 'on call' over the whole of a 56-80 hour period, with considerable disruption of sleep. Performance at the end of this weekend shift showed dramatic decrements on all aspects of the decision-making task, and large increases in subjective fatigue (though not subjective workload or anxiety). Fatigue, in this case, involves a combination of workload and sleep disturbance, and the basal capacity for responding actively is likely to be actively impaired.

Effects of Work Changes. A third junior doctors study is currently under way, evaluating the possible benefits of an innovative change over in working conditions. This provides non-medically qualified support workers to carry out routine tasks such as portering, venepuncture and IV influsions. Two hospital teams, one medical and one surgical, are allocated a support worker, with two other teams acting as control groups. The effects of the changes are being evaluated over a 2-year period, to assess effects on objective patterns of work, subjective work demands and resources, health symptoms and longer-term changes in mental health. Again, strong overall relationships are evident between workload and strain, especially the anxiety dimension. The impact of the organisational change appears to be rather specific, however. Although only preliminary data are available, the presence of a support worker has the effect of reducing the level of reported fatigue, once again with no effect on anxiety. This is intriguing since the work which may be transferred to the support workers involves routine, low level activities, rather than the more demanding medical tasks. Overall workload is slightly higher, with cognitive demand especially increased, but control is also higher with the new work pattern. The results of a formal activity sampling of work sessions (direct observation of work activity) were also revealing, and perhaps implicate a more fundamental fatigue-factor. Apart from the dramatic changes in work patterns (confirming the anticipated transfer of routine activities to support workers), the groups with support workers were found to be able to increase their morning and afternoon break times from a mean of less than 5 mins to around 30 mins per day.

Conclusions

Anxiety and fatigue give different patterns of change under variations in workload and control. Having a model which locates these sources of affect in the activity of specific control mechanisms allows us to predict how each should respond to changes in features of the work environment, and the moderating effects of individual coping characteristics. Anxiety reflects perceived level of demand; fatigue the level of engagement in the response to that demand. Our examples from the various studies with junior doctors, while based on small samples, vividly illustrate these general principles, for individuals and for whole groups. They also suggest the possibility of a switch in the affective response to mental demands, within the same person, with a change in baseline state (following a holiday), and the possibility of reducing overall levels of fatigue by removing not the more difficult but the more routine demands.

The kind of approach advocated here allows us to examine the mechanisms underlying work-performance-health relationships. We believe that study of the pattern of affect and performance (in combination with measures of coping skills and psychophysiological states, neither of which we have been able to deal with adequately here) will be very productive. Such a methodology will also allow us to address such issues as the longer-term effects of fatigue on the adaptive process, and on health and well-being, through a systematic study of after-effects of work. We would argue that fatigue from continued control at an 'uncomfortably high' level will result in an erosion of adaptive capacity, for example through a downwards-regulation of effort set points. This could only be seen through an analysis of individual cases, such as the $n=2$ study reported above. It would, however, require a sample of perhaps 100, and a time period of at least a year, though less frequent observation. In this period one might expect 5-10 people to develop adaptational problems, and we would be able to track them in detail.

Chronic effects of fatigue may represent an apparently maladaptive form of the normal self-regulatory process, which may underlie the kind of cognitive symptoms observed

in burnout or states such as post-viral fatigue. A contributory factor in this dysregulation is certain to be a failure to switch off from work or 'unwind' (Frankenhaeuser, 1986). While work is a periodic activity, for many people it is effectively a chronic stressor. This is partly because of a growing requirement to take work home, and partly because of the carry-over effects of work fatigue because of poor demand management strategies. It is quite common in jobs such as nursing, teaching and social work for these effects to persist for most or all of the time between work shifts. Research on stress has largely ignored the problem of cumulative effects of stressors, and we have no explicit model for such effects. This is a major issue for a modern approach to work strain and the management of its effects.

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